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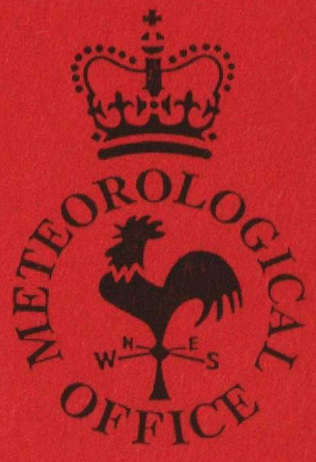

FORECASTING SYSTEMS TECHNICAL NOTE NO.6

SUMMARY of TROPICAL CYCLONE ACTIVITY and FORECASTS in the 1995-6 SOUTHERN HEMISPHERE SEASON

J.T.HEMING

DECEMBER 1996

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This paper has not been published. Permission to quote from it should be obtained from the head of Forecasting Systems.

1. INTRODUCTION

A summary of tropical cyclone activity in the southern hemisphere for the 1995-6 season is presented below together with an assessment of the performance of the global model in predicting the tracks of these tropical cyclones.

Tropical cyclones are experienced in the South Indian Ocean, tropical seas to the west, north and east of Australia and the western South Pacific Ocean. For the purpose of tropical cyclone verification the southern hemisphere is divided in to two basins; the South-West Indian (west of 90°E) and Australian (east of 90°E). Mean error statistics for each basin are presented together with a table of statistics for the whole southern hemisphere. The global model produces a 6-day forecast every 12 hours. Verification is performed at 24 hour intervals up to forecast time T+120.

The present global model has a resolution of 1.25°x 0.83°x 19 levels. This is equivalent to a horizontal resolution of 139km x 93km at the equator. The tropical cyclone verification scheme identifies the centre of a tropical cyclone in the model by locating a local maximum of relative vorticity at 850hPa. A surface fitting technique is used to locate the centre accurately.

The terms used in the statistics tables are explained below :-

Possibly verified - No. of forecasts fulfilling requirements 1, 2 & 4 below.
Actually Verified - No. of forecasts fulfilling *all* the requirements below(*).
Mean DX - Mean of positional errors in the East-West direction.
Mean DY - Mean of positional errors in the North-South direction.
Mean AT - Mean of positional errors in the Along Track direction.
Mean CT - Mean of positional errors in the Cross Track direction.
Skill - Percentage skill of model against CLIPER.
Mean DPE - Mean of direct positional errors.
All errors are measured in kilometres except where indicated.

(*) 1. Observed maximum wind at least 31 knots at the verifying time.
2. Forecast tropical cyclone centre equatorwards of 40 degrees.
3. Forecast tropical cyclone centre relative vorticity above a critical limit for verification (0.55×10^{-4} per second).
4. Observation within 6 hours of verifying time present for use in verification.

Forecast skill is defined as:- $\frac{\text{CLIPER DPE - Model DPE}}{\text{CLIPER DPE}} \times 100\%$

Positive skill indicates the model forecast is better than CLIPER.
Negative skill indicates the CLIPER forecast is better than the model.

A diagrammatic explanation of other error statistics and their sign conventions can be found in Appendix A. Full details of the TC verification scheme can be found in nwp Gazette, Vol.1, No.2, December 1994.

Advisory positions primarily from JTWC Guam are used as verifying observations of storm location when track verification is carried out immediately after a storm has ended. Best track data from RSMCs La Réunion and Nadi, Fiji and Bureau of Meteorology, Australia have been obtained for this season's storms and the track forecasts verified again. Statistics for verification against best-track observations are presented in detail. Some statistics for verification against real-time observations (from JTWC, Guam and RSMC, Fiji) are included for the purposes of a comparison. Some mean error statistics for last season are also included for the purposes of a comparison. Forecast tracks are only verified when a depression reaches tropical storm status.

2.TROPICAL CYCLONE ACTIVITY

	SWI	AUS	TOTAL
Total number active 1994-5	13 (11)	11 (9)	24 (20)
Total number active 1995-6	10 (10)	18 (17)	28 (27)

Basin name abbreviations:- SWI = South-West Indian (west of 90°E)
AUS = Australian (east of 90°E)

The number in brackets indicates the number of depressions which reached tropical storm status (maximum sustained wind above 33 knots).

3. SUMMARY OF ALL SOUTHERN HEMISPHERE STORMS

3.1 South-West Indian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	118	99	81	64	49	36
Actually Verified	118	94	70	52	41	28
Mean DX	-1	-46	-49	-4	95	252
Mean DY	17	27	54	6	-21	-4
Mean AT	-24	-57	-110	-119	-229	-350
Mean CT	6	-10	-4	-20	13	11
Mean Skill (%)	****	-10	16	25	****	****
1994-5 Skill (%)	****	-6	28	24	****	****
Mean DPE	93	185	318	427	525	732
1994-5 DPE *	84	176	270	409	570	729
RT DPE #	76	186	315	437	530	711

* DPE for all South-West Indian storms in 1994-5 season
\# DPE calculated using real time observations as opposed to best track.

Comments :
A plot of the observed tracks of all storms in this basin can be found in Fig. 1.

There was slightly less tropical storm activity this season than last in the South-West Indian basin. Forecast errors were slightly higher last season's figures except at T+96. Skill scores were lower than last season at T+24 and T+48, but 1% higher at T+72. Figs. 2 and 3 show forecast errors and skill scores for the last few seasons and indicate that the slight worsening of figures this season compared to last is small compared to the improvements in recent years. There was a slow bias in this season's forecast tracks.

3.2 Australian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	131	94	64	36	21	12
Actually Verified	131	90	52	29	15	8
Mean DX	9	2	-33	-97	-442	-650
Mean DY	9	31	13	-106	-326	-604
Mean AT	-4	-43	-82	-298	-460	-799
Mean CT	-4	-15	-60	-161	-400	-270
Mean Skill (%)	****	10	20	-15	****	****
1994-5 Skill (%)	****	39	41	23	****	****
Mean DPE	91	203	297	553	782	1148
1994-5 DPE *	62	199	342	462	713	****
RT DPE #	82	203	307	565	804	1173

* DPE for all Australian storms in 1994-5 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

A plot of the observed tracks of all storms in this basin can be found in Fig.4.

There was almost double the tropical storm activity this season than last in the Australian basin. Most of this additional activity occurred in the South-East Indian Ocean - particularly off the north-west coast of Australia. Forecast errors were higher than last season at T+72 and beyond, but were still lower than all seasons prior to last season. Figs. 5 and 6 show forecast errors and skill scores for the last few seasons. Like last season, there was an overall slow bias and a right-of-track bias in forecasts this season.

3.3 Combined Statistics for whole Southern Hemisphere

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	249	193	145	100	70	48
Actually Verified	249	184	122	81	56	36
Mean DX	4	-22	-42	-37	-48	51
Mean DY	13	29	36	-33	-103	-137
Mean AT	-14	-50	-98	-183	-291	-449
Mean CT	1	-12	-28	-70	-97	-51
Mean Skill (%)	****	1	18	13	****	****
1994-5 Skill (%)	****	13	32	24	****	****
Mean DPE	92	194	309	472	594	824
1994-5 DPE *	76	184	289	418	576	729
RT DPE #	79	195	312	483	603	814

* DPE for all southern hemisphere storms in 1994-5 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

Figs. 7 and 8 show forecast errors and skill scores and Figs. 9 and 10 along-track and cross-track errors over the last few seasons .

The combined statistics for the whole southern hemisphere indicate that forecast errors were 3-13% higher and skill scores 9-15% lower than last season. Despite errors being higher than last season overall, they were still less than in any other previous season. Whilst cross-track errors remained fairly small, the negative along-track (slow) bias continued on an upward trend and accounts for the increase in forecast error this season.

On average, there was only a small difference between forecast errors derived using real-time observations and those derived using best track observations.

Further Tropical Cyclone Information

The Met. Office pages on the World Wide Web contain information on tropical cyclone forecasting at the Met. Office. Monthly bulletins of tropical cyclone activity and forecasts are held together with observed and forecast track information of recent storms, track prediction error statistics, lists of names, images, movies and photographs and details of advances made in tropical cyclone track prediction at the Met. Office.

The Met. Office web site is:- **http://www.meto.gov.uk**
Tropical Cyclone information can be found under the section "The weather & how we forecast it".

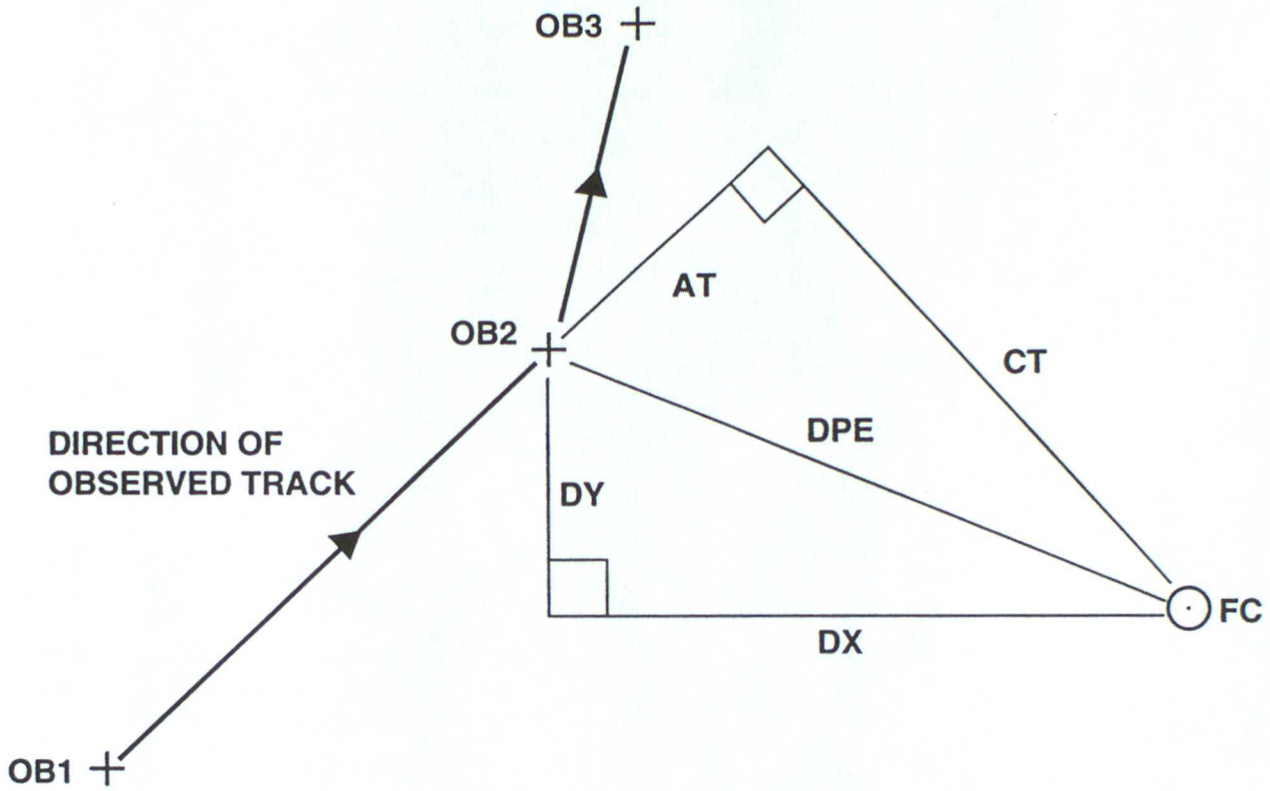
The information above is also available on the Met. Office internal web under Julian Heming's home page. Contact Julian Heming (jheming@meto.gov.uk) or Alan Radford (amradford@meto.gov.uk) for further information on tropical cyclone forecasting at the Met. Office.

Acknowledgements

CLIPER models for various basins were supplied by Mr.S.Lord, NMC, Washington, USA and Mr.C.Mauck, FNOC, Monterey, USA.
GrADS software used to produce track plotting charts was supplied by Mr.S.Lord and Dr.M.Fiorino.
Best track observations for the southern hemisphere were supplied by RSMC Météo-France, La Réunion, Bureau of Meteorology, Australia and RSMC Nadi, Fiji.

APPENDIX A

Diagrammatic Explanation of Forecast Errors



OB1-3 : Observed positions
FC : Forecast position verifying against observation OB2
DPE : Direct positional error
DX : Error in the East-West direction
DY : Error in the North-South direction
AT : Error in the Along Track direction
CT : Error in the Cross Track direction

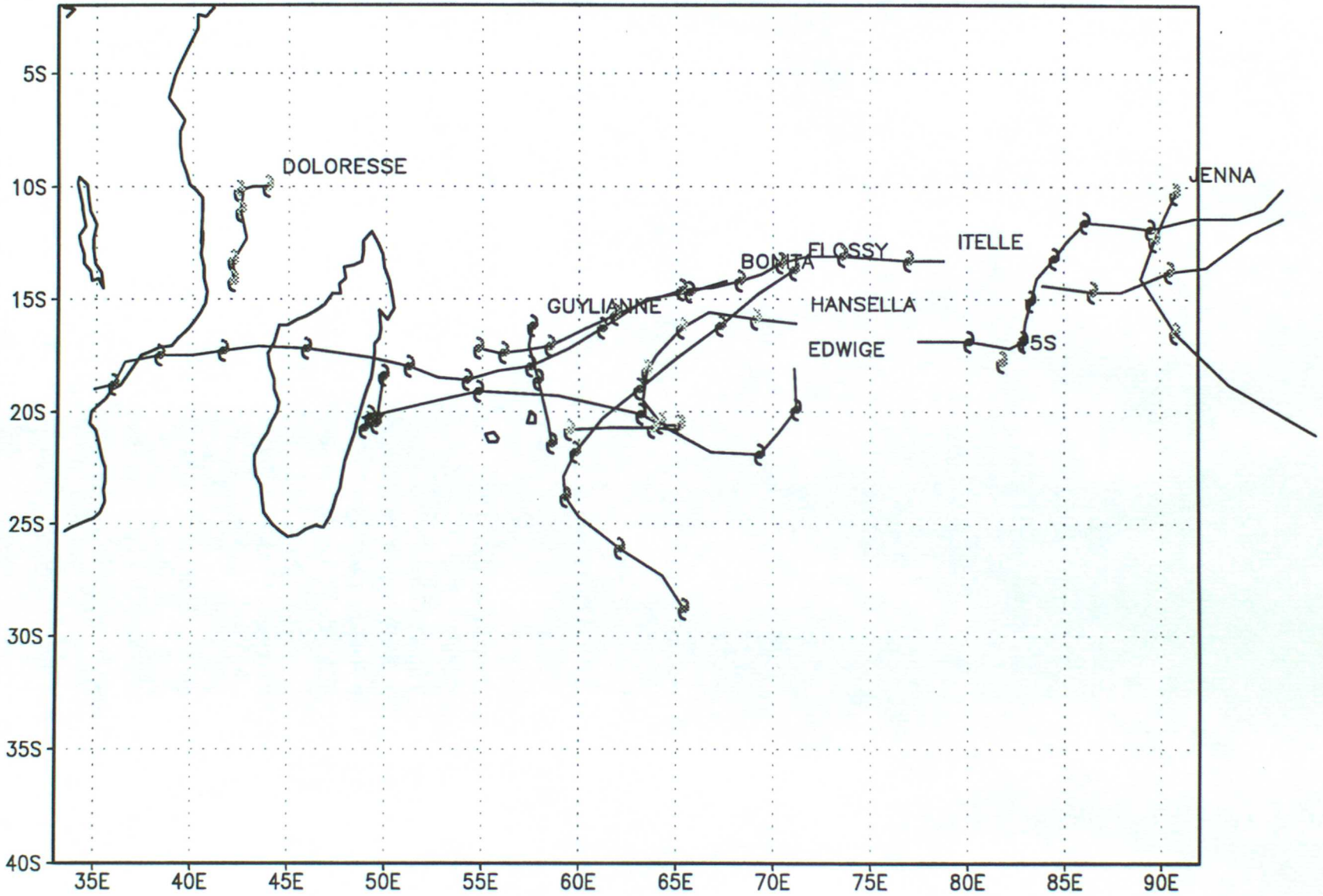
All errors are measured in kilometres

Sign Conventions

DPE values are always positive.
DX errors are positive if the forecast position lies eastwards of the observed position.
DY errors are positive if the forecast position lies polewards of the observed position.
AT errors are positive if the forecast position lies ahead of the observed position along the tropical cyclone track.
CT errors are positive if the forecast position lies right of the observed track in the northern hemisphere and left of the observed track in the southern hemisphere.

Figure 1

OBSERVED TRACKS of TROPICAL CYCLONES in the SOUTH–WEST INDIAN BASIN



AGNIELLE 951117 BONITA 960106 HUBERT 960108 DOLORESSE 960215 15S 960216 EDWIGE 960222
FLOSSY 960227 GUYLIANNE 960321 HANSELLA 960403 ITELLE 960409 JENNA 960503
KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 12Z POSITIONS

Figure 2
South-West Indian Tropical Cyclone Forecast Positional Errors

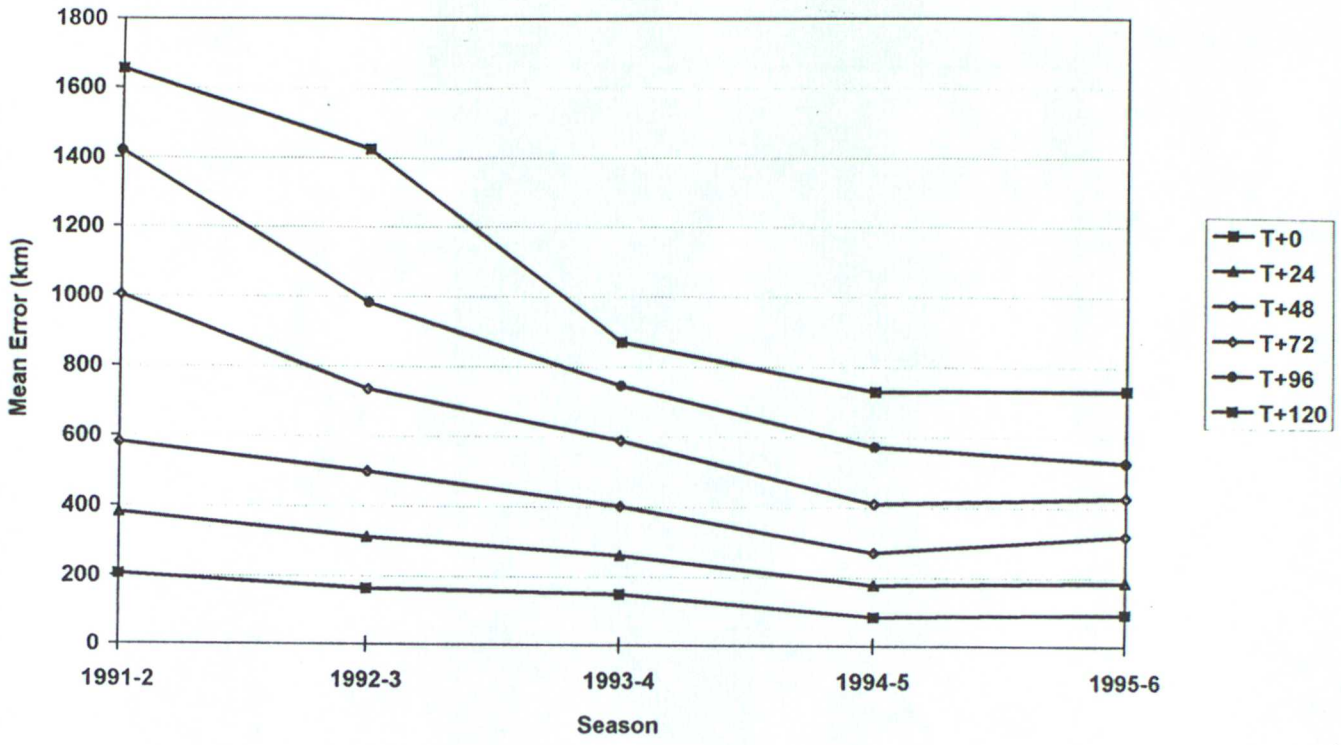


Figure 3
South-West Indian Tropical Cyclone Forecast Skill against CLIPER

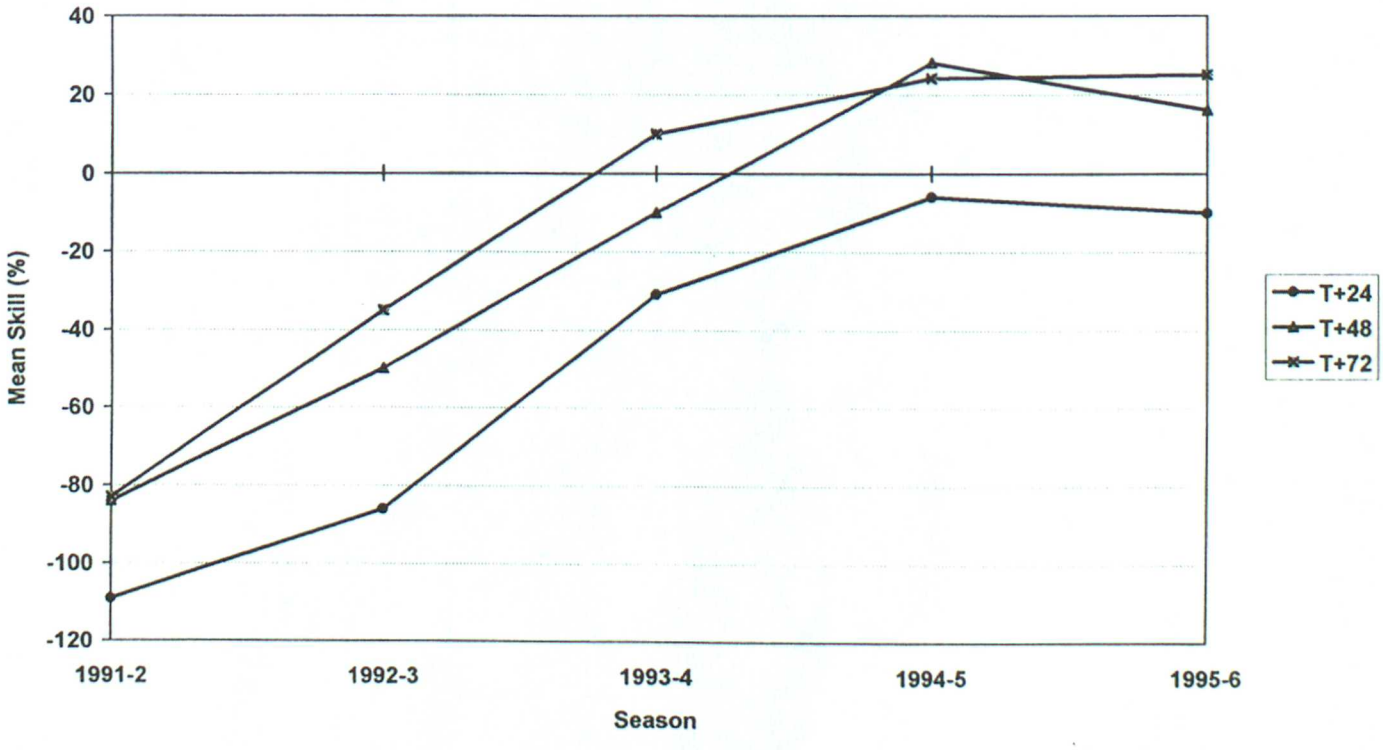
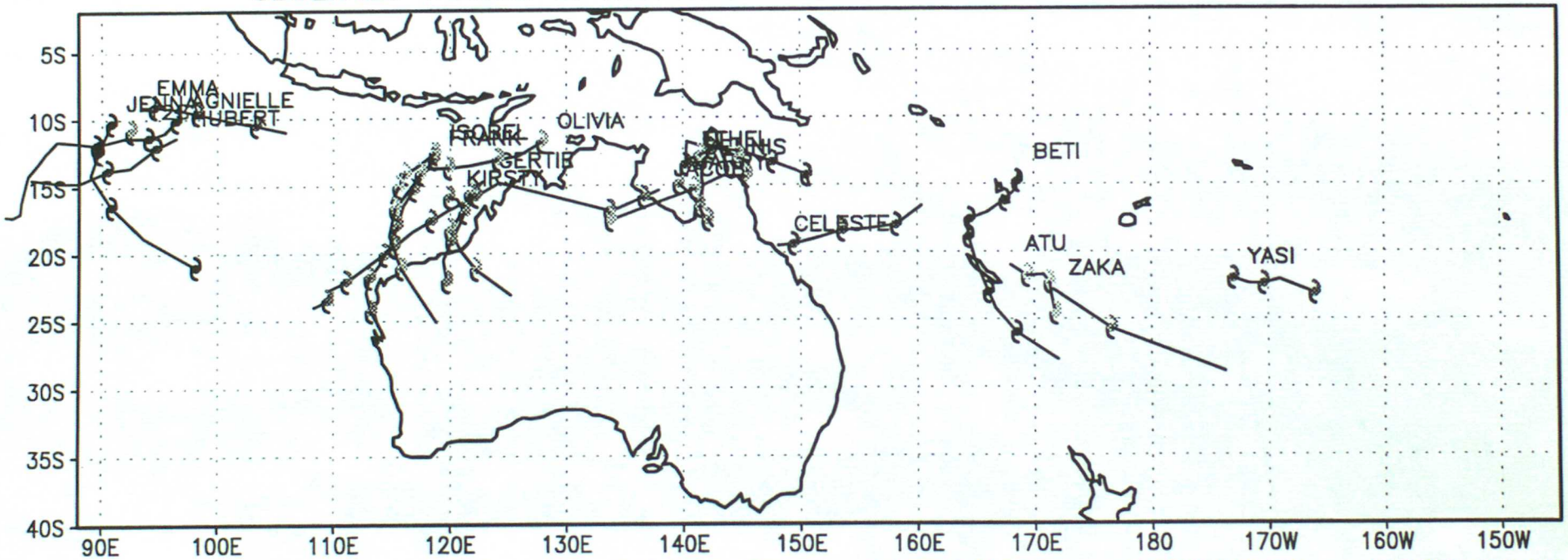


Figure 4

OBSERVED TRACKS of TROPICAL CYCLONES in the AUSTRALIAN BASIN



AGNIELLE 951117 EMMA 951209 FRANK 951207 GERTIE 951218 BARRY 960104 HUBERT 960108
YASI 960116 CELESTE 960127 ISOBEL 960128 JACOB 960128 12S 960207 DENNIS 960214
KIRSTY 960309 ETHEL 960309 ZAKA 960310 ATU 960311 BETI 960323 OLIVIA 960405
JENNA 960503

KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 12Z POSITIONS

Figure 5
Australian Tropical Cyclone Forecast Positional Errors

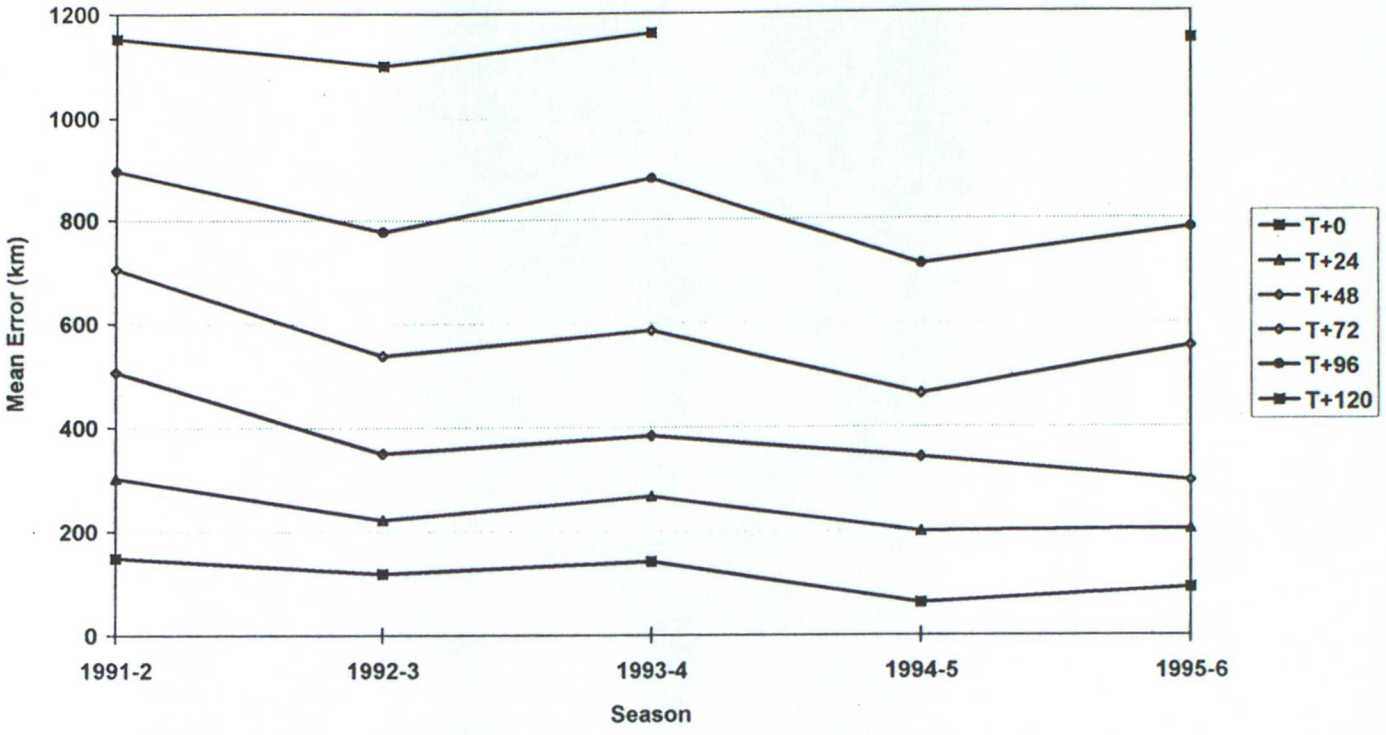


Figure 6
Australian Tropical Cyclone Forecast Skill against CLIPER

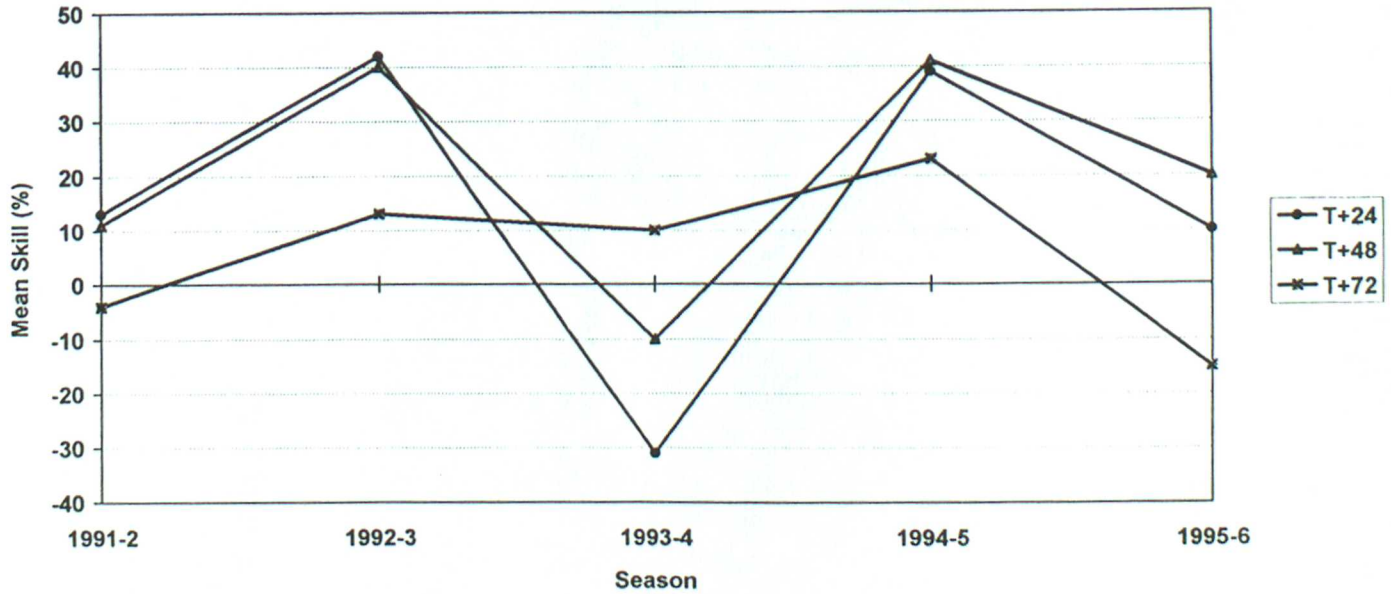


Figure 7
Southern Hemisphere Tropical Cyclone Forecast Positional Errors

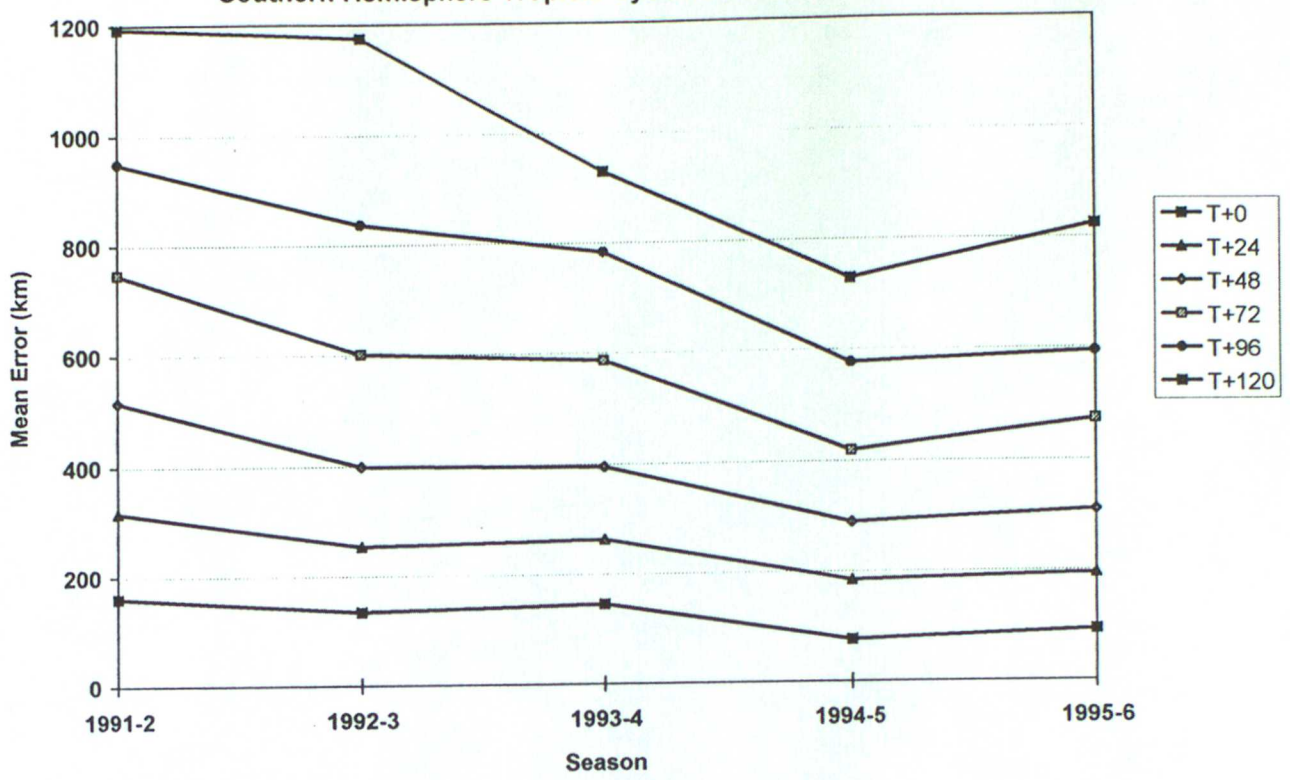


Figure 8
Southern Hemisphere Tropical Cyclone Forecast Skill against CLIPER

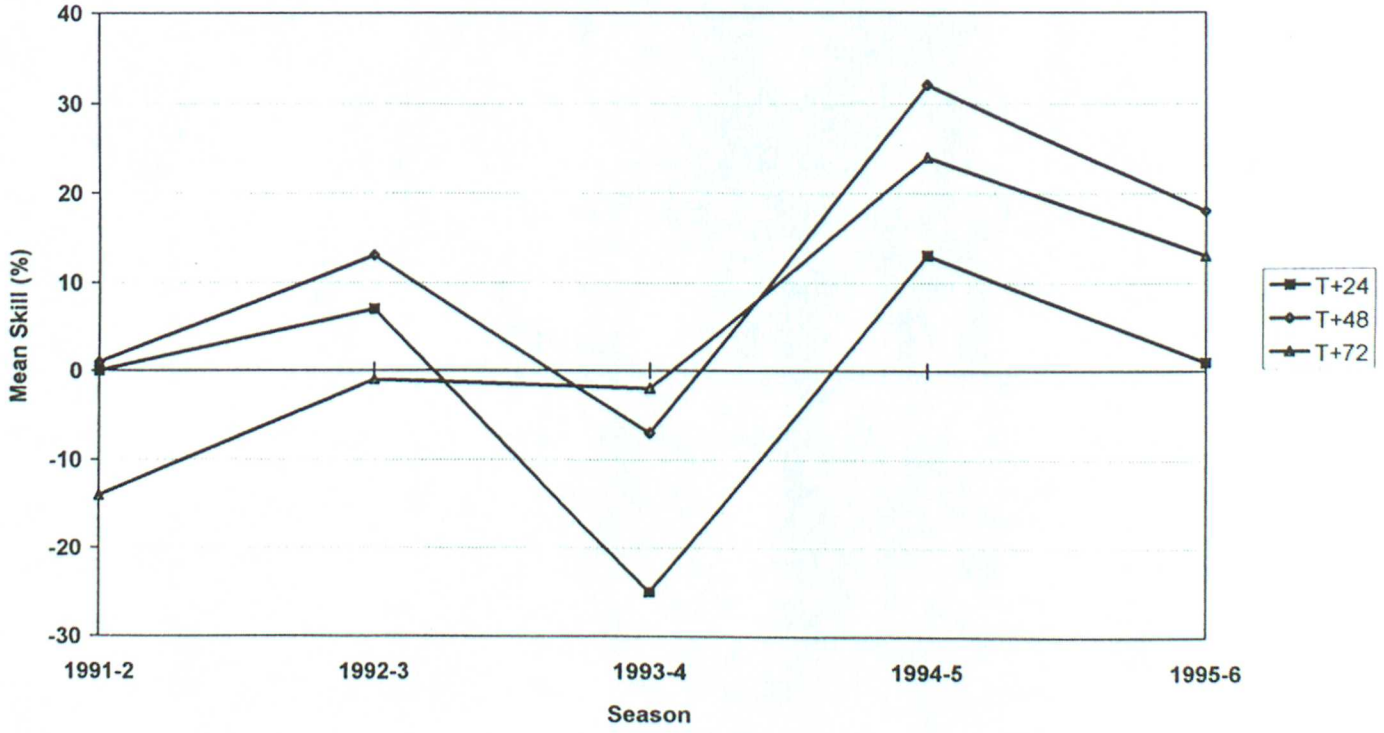


Figure 9
Southern Hemisphere Tropical Cyclone Along Track Forecast Errors

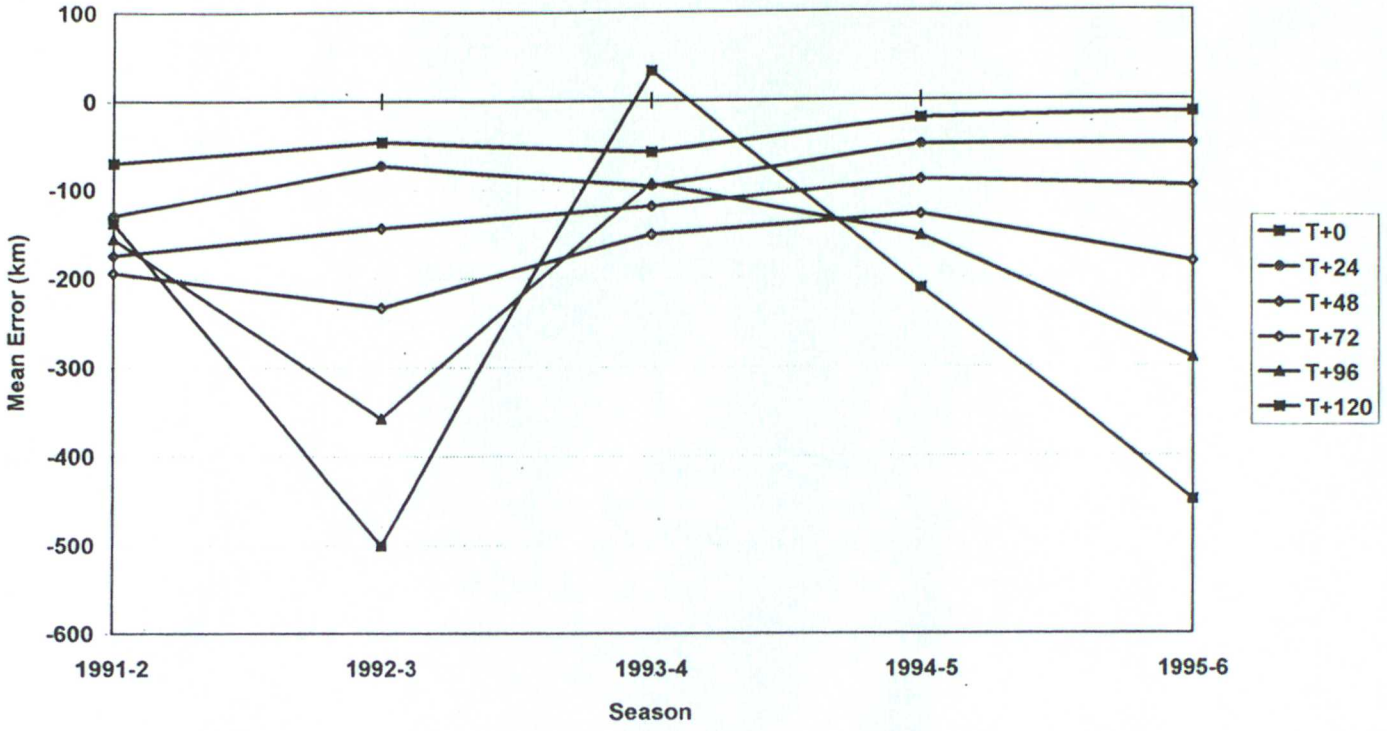


Figure 10
Southern Hemisphere Tropical Cyclone Cross Track Errors